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EP 0933823 A2 **JP 2002033521 A**
US 20010002049 A1

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(54) Abstract Title
Hybrid LED

(57) Hybrid LED having a radiation-emitting semiconductor body (chip) (2) which is surrounded by a housing which comprises at least a base body (6) and a cap (18), the chip being seated in a recess (5) of the base body, and the primary radiation of the chip being converted at least partially into longer wavelength radiation by a conversion means (17). This conversion means may be a luminescent material, possibly luminescent glass or an inorganic intercalation luminescent material. The cap is formed by a glass-type body, which may be glass or glass ceramic amongst other things, the conversion means being contained in or included in the glass-type body.

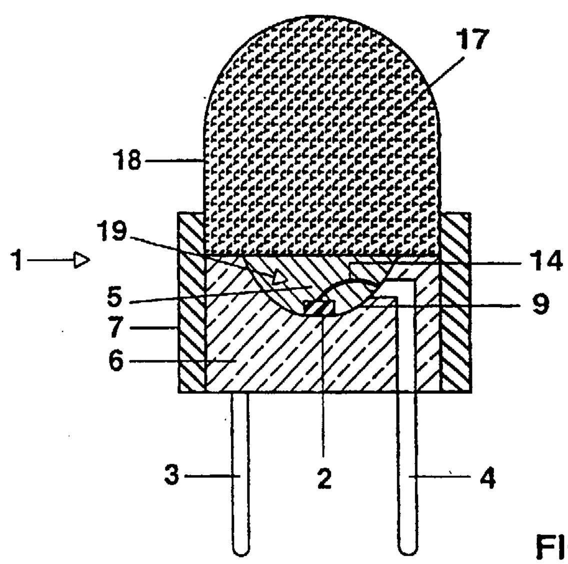

FIG. 2

GB 2 381 125 A

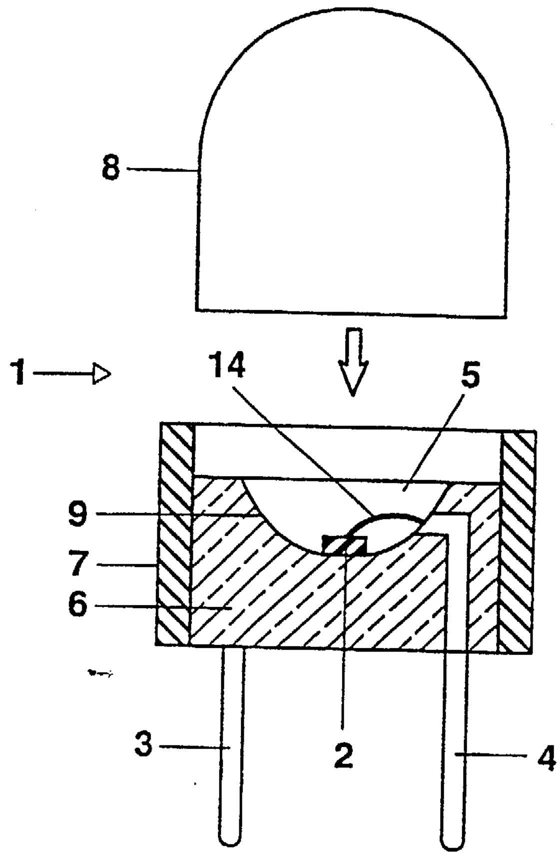

FIG. 1

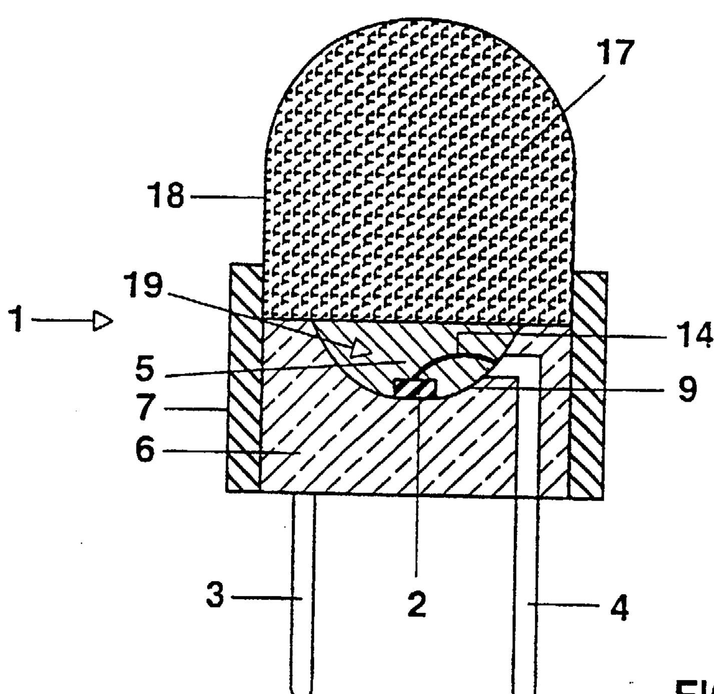

FIG. 2

Hybrid LED

The invention relates to a hybrid LED. In particular, it relates to a hybrid LED which generates white light.

US-A 5 966 393 discloses a hybrid LED for which a part of the housing can be produced from glass. A conversion of the primary emitted light is provided here by thin films or layers on the LED chip. In a similar way, DE-A 198 03 936 also describes a primary UV-emitting LED, for which a part of the housing can consist of glass. The conversion is performed here by thin layers on surfaces of the separate housing.

It is desirable to provide a hybrid LED, which is particularly compact and easy to construct. In particular the hybrid LED may be of the type having radiation-emitting semi-conductor body (chip), which is connected to electric terminals and surrounded by a housing which comprises at least one base body and a cap, the chip being seated on the base body, in particular a recess of the base body, and the primary radiation of the chip being converted by a conversion element at least partially into longer wave radiation. A further desideratum is to provide an LED which is resistant to the emitted UV radiation and has a high optical outcoupling efficiency.

The invention is defined in the independent claim, o which reference should now be made. Particularly advantageous refinements are to be found in the dependent claims.

A luminescence conversion LED (lucoled) is based usually on an LED chip whose primary emission is in the UV or short wave blue spectral region (300 to approximately 460 nm). This radiation is subsequently entirely or partially converted by a conversion element (usually a luminescent material) into longer wave radiation.

It is therefore possible to produce either very stable coloured LEDs, or else to utilize mixing effects such as, for example, the production of white light. This comes about through suitable mixing of individual luminescent materials and/or suitable tuning of the intensity of primary and secondary light. It is therefore possible, in particular on the basis of an LED emission with a blue primary emission, to produce lucoleds with defined colour spectra, for example complex mixed colours (magenta) and white light according to the principle of additive colour mixing. The luminescent materials are frequently organic dye molecules or inorganic pigment powders. They are usually embedded in a sealing compound.

In the case of chips with UV or short-wave blue emission, in particular in the region from 300 to 430 nm peak emission, a particularly severe problem arises that the known sealing compound (to date epoxy resin) is not sufficiently stable against this short-wave radiation. After lengthy irradiation, a permanent discoloration of the sealing compound occurs, and this leads to degradation of the optical transmission which disadvantageously influences both the luminous intensity and the spectral emission characteristics of the lucoleds.

Previous solutions, as outlined above, are complicated or dependent on special conditions.

According to embodiments of the invention, a hybrid design is now provided in which the sealing compound is replaced by an element (glass-like cap) which consists of an inorganic glass and itself contains or includes the conversion means. The whole element forms the conversion element. Thus, the conversion element may be made of converting UV resistant glass.

Preferably, the hybrid LED is provided with a radiation-emitting semiconductor body which can, in particular, be an InGaN chip. The chip is connected to electric terminals, for example it is fastened on an electrically conducting lead frame and surrounded by a housing. The latter comprises at least a base body and a cap, the chip being seated on the base body, in particular in a recess of the base body. To optimize the optical outcoupling efficiency of the primary radiation, the conversion element (in particular a cap) is connected with the aid of a UV-resistant silicone-based optical coupling gel directly to the radiation-emitting semiconductor body (so-called n-matching). The primary radiation of the chip is converted at least partially into longer wave radiation by a conversion element.

A partial conversion is appropriate whenever the primary radiation is in the visible spectral region, that is to say for a peak wavelength of at least 440 nm. A complete conversion is to be recommended in the case of a primary radiation with a wavelength of at most 430 nm, since this cannot be used in the visible spectral region.

According to embodiments of the invention, the cap is formed by a glass-like (or glass-type) body, the conversion means being contained in (or included within the material of) the glass-like body. The glass-like body is formed from glass, glass ceramic or quartz glass. It is preferred to make use of silicate and borate glasses, it being possible to configure the glass composition such that they are adapted to the chemical behaviour and the thermal expansion response of the luminescent materials and of the LED construction materials. The glass-like body should be transparent to the primary emitted radiation.

Normally, in this case the conversion element is a luminescent material which is dispersed in the glass-like body. The dispersion can either be homogeneous or be concentrated on specific regions, in particular when the outcoupling and conversion elements are optimized. A further embodiment is a hybrid LED in the case of which the glass-like body is directly a luminescing glass, the conversion means being formed by constituents of the luminescing glass. Particularly suitable as luminescent materials are what are termed inorganic intercalation luminescent materials. Suitable for this purpose, for example, are luminescent materials such as are described in US-A 5 531 926 and US-A 5 674 430. Particularly suitable in concrete terms is one of the rare earth garnet types of luminescent material (for example YAG:Ce), thiogallate or else chlorosilicate. A suitable type of luminescing glass is presented in EP-A 338 934.

Glasses or other glass-like bodies are generally inert to UV radiation. Since the processing temperature of glasses is far above 300°C as a rule, it is not possible for a direct fusion with the chip itself or the structure containing the chip to occur. It is advisable to provide a recess on the glass body or on the base body for the chip. The chip is preferably arranged in a recess of the base body which can additionally take over the function of a reflector. The electric terminals can also be fixed in the base body. The cap and the base body can be a one-piece construction or can be joined by plugging, clamping, bonding or welding, and be connected permanently in a gas-tight fashion. In this case, in particular, the recess (preferably including the entire housing interior: that is, the cavity between chip and cap) can be filled with a UV-stable optical medium of high refractive index (above 1.4, in particular 1.4 to 1.5) for the purpose of better optical coupling. A silicone composition or optical grease may be given as examples.

A particular advantage is that this design permits the use of non-curable optical coupling media, in particular of liquids.

The production of the glass body can be performed by mixing a glass frit (in powder form) with the suitable proportion of luminescent material powder (or mixtures of pulverulent luminescent materials). Subsequently, the glass offset is melted, then cast and pressed.

The glass body can be shaped so as to achieve desired optical effects with reference to light propagation. For example, it can have the shape of a lens or be configured as a Fresnel lens system. The surfaces of the glass body can, moreover, be coated with reflector layers, antireflection layers, etc. in order to achieve optimum light outcoupling and homogeneous light distribution. The luminescent pigment can either be distributed homogeneously, or be applied at special locations in the glass body.

In principle, the glass body can also be a glass ceramic in the case of which a crystalline phase results after production of the glass body by a thermal treatment. This phase can also constitute the luminescent material.

Furthermore, the glass of the glass body can itself take over the luminescence conversion when a luminescent glass is used. It is then possible to dispense entirely or partially with the use of separate luminescent pigments.

The invention is explained in more detail below with the aid of a plurality of exemplary embodiments. In the drawings:

Figure 1 shows a luminescence conversion LED, in section, and

Figure 2 shows a further exemplary embodiment of a luminescence conversion LED.

A luminescence conversion LED 1 is shown in Figure 1. The core is the chip 2, which emits primary UV radiation and is connected to electric terminals 3, 4. One of the latter is connected to the chip via a bond wire 14. The chip 2 is seated in the recess 5 of a base body 6, for example made from plastic. The wall of the recess is shaped as a reflector 9. The base body 6 is surrounded by side walls 7. Mounted on the base body 6 is a lens-shaped cap 8. It is connected to the base body 6 permanently or by an adhesive. The cap 8 is made from a luminescent glass. The latter converts the primary radiation, emitted in the UV (at a peak wavelength of 400 nm) completely (or else partially) into longer wave visible radiation. In one variant, it is a glass with a specific emission peak such that the emission appears coloured. A further embodiment is a mixture of two or more glasses that are selected such that the entire emission appears white.

A further, particularly preferred exemplary embodiment is shown in Figure 2. The same components are denoted by the same reference numerals. By contrast with the first exemplary embodiment, use may be made here of a cap 18 that consists of glass in which one or more luminescent materials 17 is/are dispersed homogeneously as pigment. Moreover, the recess 5 is filled with an optical coupling medium 19. In one variant, this is a luminescent material with a specific emission peak such that the emission appears coloured. A further embodiment relates to a mixture of two or more luminescent materials that are selected such that the entire emission appears white.

The cap 18 has optical properties, in particular it can have an optical Fresnel lens, a bifocal lens, a plano-convex or a plano-concave lens.

The housing is shown as a two-piece construction, but the skilled person will appreciate that the cap and base body may alternatively be made in one piece, both being made of the glass-type material.

Claims

1. A hybrid LED having a radiation-emitting chip (2), which is connected to electric terminals (3, 4) and surrounded by a housing which comprises at least one base body (6) and a cap (8), the chip (2) being seated on the base body (6), and the primary radiation of the chip being converted by a conversion element at least partially into longer wave radiation, characterized in that the cap (8) is formed by a glass-type body, the conversion means being included in the glass-type body.

2. A hybrid LED as claimed in claim 1, wherein the glass-type body is formed from glass or glass ceramic.

3. A hybrid LED as claimed in claim 1 or 2 wherein the conversion means is a luminescent material (17) which is dispersed in the body.

4. A hybrid LED as claimed in claim 1 or 2, characterized in that the conversion means is formed by constituents of a luminescing glass.

5. A hybrid LED as claimed in claim 3, characterized in that the luminescent material is formed by an inorganic intercalation luminescent material.

6. A hybrid LED as claimed in any of the preceding claims, characterized in that the recess is filled with an optically transparent medium (19) with a high refractive index.

7. A hybrid LED as claimed in any of the preceding claims, characterized in that the cap (8; 18) has optical properties, in particular a Fresnel lens system, a bifocal lens, a plano-convex or plano-concave lens.

8. A hybrid LED as claimed in any of the preceding claims, wherein the chip is seated in a recess (5) of the base body.

9. A hybrid LED as claimed in any of the preceding claims, wherein the chip (2) includes a radiation-emitting semiconductor body.

10. A hybrid LED as claimed in any of the preceding claims, wherein the recess (5) is filled with an optical coupling medium.

11. A hybrid LED as claimed in any of the preceding claims, wherein the conversion means is formed by the material of the glass-type body.

12. A hybrid LED as claimed in any of the preceding claims, wherein the housing is filled with an optical coupling medium.

13. A hybrid LED substantially according to any of the embodiments described in the description and/or shown in the figures.

10

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Application No:	GB 0214391.5	**Examiner:**	Emily McGeehin
Claims searched:	1 to 12	**Date of search:**	13 February 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1, 2, 7 to 9 and 11	EP0933823A2	WAITL et al: Figures 1a and 3 Abstract Referring to US2001/0045573A1 (enclosed): Paragraphs: 0009, 0012, 0017, 0019, 0021, 0025, 0034, 0039 and 0040
X	1, 2 to 5	US2001/0002049A1	PATENT-TREUHAND-GESELLSCHAFT FUR ELECTRISCHE GLUHLAMPEN MBH AND SIEMENS AKTIENGEESELLSCHAFT Abstract Figures 3, 4, 5 and 14 Paragraphs 0033 to 38, 0049-51, 0055-0091, 0097-0100 and 0112
X P	1, 3 and 4	JP2002-033521	SHOWA DENKO KK Abstract Figures 1 and 2 Paragraphs 0008 to 0012

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

H1K

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

H01L

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI, JAPIO, INSPEC